NATIONAL ACADEMIES OF SCIENCES AND ENGINEERING

NATIONAL RESEARCH COUNCIL

of the

UNITED STATES OF AMERICA

UNITED STATES NATIONAL COMMITTEE

International Union of Radio Science

National Radio Science Meeting

3-7 **January 1995**

Sponsored by USNC/URSI

University of Colorado
Boulder, Colorado
U.S.A.

Session B/D-2, 1355-Thurs., CR2-28
APPLICATIONS OF NEW MATERIALS FOR ELECTRONICS, DEVICES, AND SYSTEMS
Chairperson: S.A. Long, Dept. of Electrical and Computer Engineering, Univ. of Houston, Houston, TX 77004
Organizers: S.A. Long, Univ. of Houston; and J.W. Mink, Army Research Office

B/D2-1
1400

MODELING OF SUPERCONDUCTING TRANSMISSION LINES FOR MICROWAVE CIRCUIT APPLICATIONS

Jeffrey M. Pond
Microwave Technology Branch
Naval Research Laboratory
Washington, DC 20375

Accurate and efficient modeling of superconducting transmission lines is needed in order to fully exploit the advantages of high-temperature superconductors (HTS) for microwave circuit applications. One of the principle microwave application areas that should benefit from HTS technology is that of very narrow bandwidth (<l%) filters. Microwave losses of thin-film-based distributed filters fabricated using I-ITS as opposed to normal metals can have insertion losses of approximately 1 dB instead of more than 10 dB when the bandwidth is small (A. Fathy, et. al., 1993 IEEE MTT-S IMS Digest, 3, 1277-1280, 1993). Of course, in order to fabricate such a filter and have it work according to design it is necessary to be able to design the resonant elements to very tight tolerances. Although narrowband filters have been fabricated which have very good pass band shapes, present computer aided design techniques are, in general, unable to account for the internal fields of the superconductor and hence it is very difficult to design for a precise center frequency.

Computational considerations limit the use of electromagnetic field solvers to relatively simple geometries since the fields internal to the superconducting films as well as the external fields must be modeled. Obviously, considerable computational efficiency can be gained if the internal fields of the superconductor do not need to be solved and yet the affects of the superconductor can still be retained. A surface impedance description is insufficient because the thickness of most high quality I-ITS films is on the order of the superconducting penetration depth. However, another approximate boundary condition, the resistive boundary condition (T.B. A. Senior, Radio Sci., 10,645650, 1975), can be used in conjunction with other electromagnetic modeling approaches such as the spectral domain technique. This approach was first applied in the case of very thin superconducting films where the approximate boundary condition is well defined (J. M. Pond, et. al., IEEE Trans. on MTT, 37, 181-190, 1989). It is shown that an extension of this approach to thicker films, on the order of a penetration depth thick, is valid for most transmission line topologies of interest. Combining this approximate boundary condition with the spectral domain technique is computationally efficient and gives excellent agreement with measured results obtained from a set of HTS coplanar waveguide resonators.